

Claims

- [c1] 1. An apparatus for automatically coupling a tool to a manipulator having a spindle, the apparatus comprising: a first adapter having a spindle mating portion adapted to be coupled to the spindle and a first threaded portion disposed opposite the spindle mating portion; and a second adapter having a second threaded portion adapted to engage the first threaded portion and a tool mating portion adapted to engage the tool and disposed opposite the second threaded portion.
- [c2] 2. The apparatus of claim 1 wherein the manipulator is a multi-axis robot.
- [c3] 3. The apparatus of claim 1 wherein the first threaded portion has a male configuration and the second threaded portion has a female configuration.
- [c4] 4. The apparatus of claim 1 wherein the first threaded portion has a female configuration and the second threaded portion has a male configuration.
- [c5] 5. The apparatus of claim 1 wherein the tool mating portion has a male configuration.

- [c6] 6. The apparatus of claim 1 further comprising a tool magazine having a tubular portion adapted to receive the tool therein and a raised portion disposed in the tubular portion and adapted to engage the tool to inhibit rotation of the tool when the manipulator rotates the first adapter with respect to the second adapter.
- [c7] 7. The apparatus of claim 6 further comprising a proximity sensor disposed in the tubular portion that detects presence of the tool.
- [c8] 8. An apparatus for automatically coupling a fastener tool to a multi-axis robot having a spindle, the spindle being adapted to rotate about an axis of rotation and having a drive portion, the apparatus comprising:
a first adapter having a spindle mating portion adapted to engage the drive portion and a first threaded portion disposed opposite the spindle mating portion;
a second adapter having a second threaded portion adapted to engage the first threaded portion and a tool mating portion adapted to engage the fastener tool disposed opposite the second threaded portion;
wherein the spindle rotates about the axis of rotation in a first direction to engage the first and second threaded portions and rotates about the axis of rotation in an opposite direction to disengage the first and second threaded portions.

- [c9] 9. The apparatus of claim 8 wherein the first threaded portion has a male configuration and the second threaded portion has a female configuration.
- [c10] 10. The apparatus of claim 8 wherein the first threaded portion has a female configuration and the second threaded portion has a male configuration.
- [c11] 11. The apparatus of claim 8 wherein the drive portion further comprises a retaining feature adapted to engage the spindle mating portion to secure the first adapter to the spindle and inhibit movement of the first adapter along the axis of rotation.
- [c12] 12. The apparatus of claim 8 wherein the fastener tool includes a first opening adapted to receive the tool mating portion and a second opening disposed coaxially with the first opening and configured to engage a fastener.
- [c13] 13. The apparatus of claim 12 wherein the tool mating portion further comprises a tool retention feature protruding from a surface of the tool mating portion and adapted to engage the first opening to secure the fastener tool to the tool mating portion and inhibit movement of the fastener tool along the axis of rotation.

[c14] 14. The apparatus of claim 12 further comprising a tool magazine having a tubular portion adapted to receive the fastener tool therein and a raised portion disposed in the tubular portion proximate a bottom surface, the raised portion being adapted to extend into the second opening to inhibit rotation of the fastener tool when the multi-axis robot rotates the first adapter about the axis of rotation to engage or disengage the first and second threaded portions.

[c15] 15. The apparatus of claim 14 wherein the tool magazine further comprises a proximity sensor disposed proximate the tubular portion and adapted to detect the presence of the fastener tool and provide a tool detection signal to the multi-axis robot.

[c16] 16. An apparatus for automatically coupling a socket to a spindle disposed on a multi-axis robot, the spindle being adapted to rotate about an axis of rotation and having a drive portion, the apparatus comprising:
a first adapter including:
a body portion having a spindle mating opening adapted to receive the drive portion; and
a first threaded portion provided on the body portion that is coaxial with the axis of rotation;
a second adapter including:
a main portion having a first surface and a second sur-

face disposed opposite the first surface;
a second threaded portion oriented to engage the first threaded portion on the first surface and that is coaxial with the axis of rotation; and
a socket mating portion oriented to engage the socket on the second surface and is coaxial with the axis of rotation; and
a socket magazine including:
a cylindrical tubular portion having an opening for receiving the socket therein and a bottom surface; and
a surface feature provided on the bottom surface for engaging the socket to inhibit rotation;
wherein when the socket is disposed in the socket magazine proximate the surface feature the first threaded portion engages the second threaded portion when the spindle rotates about the axis of rotation in a first direction and the first threaded portion disengages the second threaded portion when the spindle rotates about the axis of rotation in an opposite direction.

[c17] 17. The apparatus of claim 16 wherein the body portion has a larger diameter than the first threaded portion to inhibit tilting of the first adapter with respect to the spindle.

[c18] 18. The apparatus of claim 16 wherein the main portion has a larger diameter than the socket mating portion to

inhibit tilting of the socket with respect to the main portion.

[c19] 19. The apparatus of claim 16 wherein the first threaded portion has a male configuration and the second threaded portion has a female configuration.

[c20] 20. The apparatus of claim 16 wherein the first threaded portion has a female configuration and the second threaded portion has a male configuration.